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(54) Title: UNDERWATER VEHICLE, SYSTEM AND METHOD FOR PERFORMING RESCUE OPERATIONS IN A BODY OF WATER

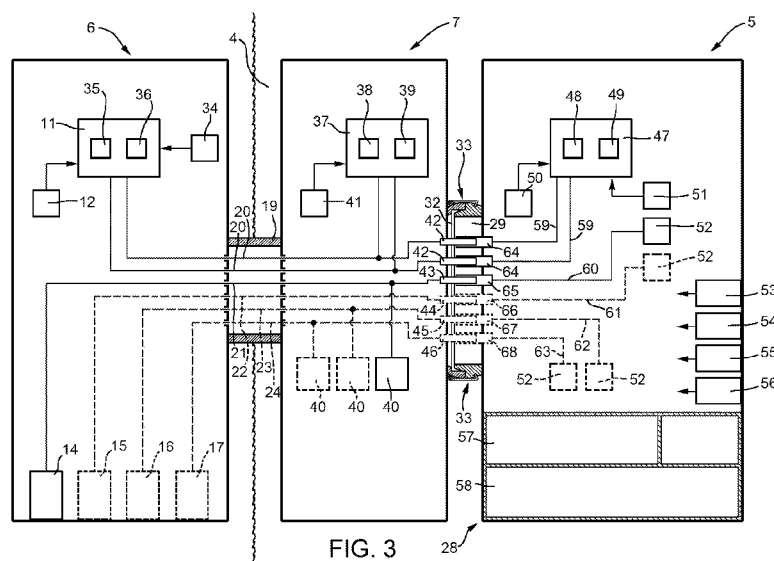


FIG. 3

(57) Abstract: An underwater vehicle for performing rescue operations in a body of water (4) comprising: a submersible hull (25); a plurality of work devices (52); a resident control device (47) designed to permit fully independent operation of the underwater vehicle (5); at least one rescue apparatus (28) for performing rescue operations in the body of water (4); and at least a first connecting device (29) for mechanically and functionally connecting the underwater vehicle (5) to an auxiliary ROV (7) when necessary, and for connecting the resident control device (47) to a remote control device (11).

"UNDERWATER VEHICLE, SYSTEM AND METHOD FOR PERFORMING RESCUE OPERATIONS IN A BODY OF WATER"

5 TECHNICAL FIELD

The present invention relates to an underwater vehicle for performing rescue operations in a body of water.

BACKGROUND ART

10 In general, underwater vehicles can be subdivided into two main categories: submarines, which are vessels guided by a crew on board and widely used for military purposes, and include DSRVs (Deep Submersible Rescue Vehicles), which are autonomous, self-propelled, small-scale submarines; and ROVs
15 (Remotely Operated Vehicles), which are widely used in the oil & gas offshore sector and in the military field, and are characterized by being connected to a support vessel by means of an umbilical along which control signals and the power necessary for ROV operation are transmitted and by not having
20 an onboard crew. DSRVs find particular application in rescue operations for the crew embarked on submarines in distress that have sunk on the bed of a body of water. In such cases, the DSRVs assigned to rescue operations are equipped with a submarine rescue chamber (SRC) and normally need a support
25 vessel due to their limited autonomy.

In general, known types of underwater vehicles assigned to rescue operations are called upon to operate in emergencies and handle unexpected situations, at least until the
30 underwater vehicle has not inspected the submarine in distress.

In particular, the conditions in which the submarine in distress finds itself, such as structural damage and/or severe
35 inclination of the submarine on the bed of the body of water and/or its rotation, can make rescue operations more difficult

and lengthen the times of these operations. In addition, the underwater vehicle assigned to rescue operations may be subject to mechanical or electrical failure or a crew member be suddenly taken ill.

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DISCLOSURE OF INVENTION

The object of the present invention is to provide an underwater vehicle that reduces the drawbacks of the known art.

10

In accordance with the present invention, an underwater vehicle is provided for performing rescue operations in a body of water, the underwater vehicle comprising: a submersible hull; a plurality of work devices; a resident control device
15 designed to permit fully independent operation of the underwater vehicle; at least one rescue apparatus for performing rescue operations in the body of water; and at least a first connecting device for mechanically and functionally connecting the underwater vehicle to an auxiliary
20 ROV when necessary, and for connecting the plurality of work devices and the rescue apparatus to at least one remote supply unit, and/or the resident control device to a remote control device.

25 Thanks to the present invention, the underwater vehicle can be supported by the auxiliary ROV, which is capable of compensating for possible breakdowns of the underwater vehicle, both with regard to the power supply and with regard to the control of the underwater vehicle.

30

In particular, the first connecting device comprises a plurality of first terminals for making respective functional connections to the auxiliary ROV.

35 In practice, the ROV is a carrier capable of implementing the functional connections to the underwater vehicle.

In accordance with the present invention, the rescue apparatus comprises a floodable chamber with the function of taking aboard any survivors present in the body of water.

5

In particular, the rescue apparatus comprises a decompression chamber selectively communicating with the floodable chamber for the purpose of subjecting the survivors to any treatment necessary before taking them back to the surface.

10

The selectively floodable chamber is preferably connectable to a submarine in distress so as to facilitate and make safer the transfer of survivors from the submarine to the underwater vehicle.

15

In particular, the resident control device is designed to operate in an independent operating mode and in a combined operating mode together with the remote control device, when the underwater vehicle is connected to the auxiliary ROV.

20

Furthermore, in the combined operating mode, the resident control device may be set selectively to master or slave mode.

The underwater vehicle is particularly versatile in terms of control management as it can be operated in complete autonomy or be remotely controlled.

25

To this end, the underwater vehicle comprises a resident user interface for controlling the resident control device and for derogating control to the remote control device.

30

To ensure fully independent operation, the underwater vehicle comprises a battery and at least one breathable air reserve.

Preferably, the underwater vehicle comprises at least a main propeller for fast movements and preferably auxiliary

35

propellers for dynamic positioning.

A further object of the present invention is to provide a system for performing rescue operations in a body of water that is free of or at least mitigates the drawbacks of known systems.

In accordance with the present invention, a system is provided for performing rescue operations in a body of water, the system comprising: an underwater vehicle provided with at least the previously described characteristics; a support vessel comprising a floating structure, at least one supply unit and a remote control device; and an auxiliary ROV equipped with a second connecting device designed to mechanically and functionally connect to the first connecting device of the underwater vehicle.

In this way, the system is able to compensate for the functional limits of the underwater vehicle.

From the practical viewpoint, the first connecting device comprises a plurality of first terminals and the second connecting device comprises a plurality of second terminals for making functional connections to the first terminals.

In this way, the mechanical connection enables making the functional connection.

The system comprises an umbilical, which is designed to connect the support vessel to the auxiliary ROV and is functionally connected to the second connecting device.

In this way, the umbilical can be connected to the underwater vehicle.

Preferably, the remote control device is housed on the support

vessel.

In accordance with one embodiment of the invention, the auxiliary ROV also comprises a further control device, which
5 is preferably controlled by the remote control device.

A further object of the present invention is to provide a method for performing rescue operations in a body of water that is free of or at least mitigates the drawbacks of the
10 known art.

In accordance with the present invention, a method is provided for performing rescue operations in a body of water, the method comprising the steps of: launching into the body of
15 water an underwater vehicle assigned to performing rescue operations for survivors on board a submarine in distress; launching an auxiliary ROV into the body of water; and mechanically and functionally connecting the underwater vehicle to the auxiliary ROV in the body of water, by means of
20 a first and second connecting device mounted on the underwater vehicle and the auxiliary ROV, respectively.

In practice, the underwater vehicle and the auxiliary ROV thus form a single vehicle with synergetic effects in terms of
25 operational capability.

In accordance with one aspect of the present invention, the method provides for functionally connecting the resident control device of the underwater vehicle to a remote control
30 device via the auxiliary ROV by means of the first and second connecting devices and an umbilical.

In the event of problems on board the underwater vehicle, its control can be taken over remotely by the remote control
35 device.

The method provides for functionally connecting at least one remote supply unit to at least one work device on board the underwater vehicle via the first and second connecting devices and the umbilical.

5

This solution enables compensating for the limited autonomy of the underwater vehicle, in particular when its capacity to power the appliances with its own resources becomes critical.

10 In accordance with the present invention, the underwater vehicle comprises at least one main propeller and preferably auxiliary propellers, and the auxiliary ROV comprises further propellers, the method comprising the step of controlling the main propeller, any auxiliary propellers and the auxiliary ROV
15 via the resident control device, or via the remote control device when the underwater vehicle and the auxiliary ROV are connected together.

This operating mode makes the underwater vehicle extremely
20 versatile.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristics and advantages of the present invention will become clear from the description that follows
25 of a preferred embodiment, with reference to the figures in the accompanying drawings, in which:

- Figure 1 is a view in elevation, with parts shown schematically and some parts removed for clarity, of a rescue system in a body of water in accordance with the present
30 invention and in a first operating mode;

- Figure 2 is a view from below, with parts shown schematically and some parts removed for clarity, of a detail of the rescue system in Figure 1 in a second operating mode;
and

35 - Figure 3 is a further schematized view, with parts removed for clarity, of the rescue system in Figure 1.

BEST MODE FOR CARRYING OUT THE INVENTION

With reference to Figure 1, reference numeral 1 indicates, as a whole, a rescue system for rescuing the crew of a submarine 2 in distress that has sunk on the bed 3 of a body of water 4.

The system 1 as a whole comprises an underwater vehicle 5 equipped for performing rescue operations, a support vessel 6 and an auxiliary ROV 7.

The rescue system 1 offers the following operating modes:

- The underwater vehicle 5 operates independently, while the auxiliary ROV 7 is stowed on board the support vessel 6;
- The underwater vehicle 5 operates independently, while the auxiliary ROV 7 monitors the rescue operations in the body of water 4;
- The underwater vehicle 5 and the auxiliary ROV 7 are mechanically and functionally connected together (Figure 2) and control of the assembly formed by the underwater vehicle 5 and by the auxiliary ROV 7 is taken by the underwater vehicle 5;
- The underwater vehicle 5 and the auxiliary ROV 7 are mechanically and functionally connected together (Figure 2) and control of the assembly formed by the underwater vehicle 5 and by the auxiliary ROV 7 is taken by the support vessel 6, which governs the operations of the auxiliary ROV 7;
- The underwater vehicle 5 and the auxiliary ROV 7 are mechanically and functionally connected together (Figure 2), the auxiliary ROV 7 integrating the functions of the underwater vehicle 5 only where this is considered opportune.

In greater detail, the submarine 2 comprises a hull 8 and a tower 9 and is shown resting on the bed 3 of the body of water 4 with a certain inclination.

The support vessel 6 comprises: a floating structure 10; a

control device 11; a user interface 12; a lifting device 13 for launching and recovering the underwater vehicle 5 and the auxiliary ROV 7; and a supply unit 14 for providing electric power. In the case shown, the support vessel 6 also comprises:
5 a supply unit 15 for providing breathable air; a supply unit 16 for providing pressurized oil; and a supply unit 17 for providing compressed air. In general, the supply units 15, 16 and 17 may be omitted and for this reason are shown with broken lines in Figure 1. The support vessel 6 comprises a
10 winch 18 designed to wind and unwind an umbilical 19 connected to the auxiliary ROV 7. In addition, the support vessel 6 is able to house both the underwater vehicle 5 and the auxiliary ROV 7 for quick transfers.

15 With reference to Figure 3, the umbilical 19 comprises: data cables 20 for signal transmission; a power cable 21 for supplying electric power; a supply hose 22 for supplying breathable air; a supply hose 23 for supplying pressurized oil; and a supply hose 24 for supplying compressed air. The
20 supply hoses 22, 23 and 24 are also shown with broken lines and may be omitted.

With reference to Figure 2, the underwater vehicle 5 comprises: a hull 25; main propellers 26; preferably, but not
25 necessarily, auxiliary propellers 27, in this case thrusters; and an apparatus 28 assigned to rescue operations. The underwater vehicle 5 comprises a connecting device 29, which, in the case shown, is arranged between the two main propellers 26.

30 With reference to Figure 2, the auxiliary ROV 7 comprises: a main body 30; a plurality of propellers 31; and a connecting device 32 designed to connect to connecting device 29. The auxiliary ROV 7 comprises a plurality of coupling devices 33
35 to firmly secure connecting device 32 to connecting device 29 and make the auxiliary ROV 7 and the underwater vehicle 5

mechanically integral.

With reference to Figure 3, the control device 11 on board the support vessel 6 controls the auxiliary ROV 7 through the umbilical 19. The support vessel 6 comprises a group of sensors 34 designed for controlling the supply of electric power, breathable air, pressurized oil and compressed air. The control device 11 comprises a processor 35 and a memory 36. The auxiliary ROV 7 comprises: an onboard control device 37 that, in turn, comprises a processor 38 and a memory 39; a plurality of work devices 40 supplied with electric power and/or compressed air and/or pressurized oil; and a group of sensors 41 designed to detect quantities related to the navigation of the auxiliary ROV 7 and the operations of the work devices 40, which can include a sonar, a camera, a device actuator, manipulators etc. The control device 37 is directly controlled by the remote control device 11.

The umbilical 19, as well as supplying the work devices 40 of the auxiliary ROV 7, is connected, not necessarily in a direct manner, to connecting device 32. In the case shown, the data cables 20 are connected to respective terminals 42, the power cable 21 is connected to a respective terminal 43, and the supply hoses 22, 23 and 24 (when present) are connected to respective terminals 44, 45 and 46. The underwater vehicle 5 comprises a resident control device 47, which comprises: a processor 48 and a memory 49; a user interface 50; a group of sensors 51; and a plurality of work devices 52. The group of sensors 51 is designed to acquire signals related to quantities of use for navigation and operation of the work devices 52.

To ensure fully independent operation, the underwater vehicle 5 comprises a battery 53, a breathable air reserve 54 when necessary, a pressurized oil reserve 55 when necessary, and a compressed air reserve 56 when necessary, for supplying the

onboard work devices 52.

The apparatus 28 comprises a decompression chamber 57 for persons rescued in the body of water, and a selectively
5 floodable chamber 58 communicating selectively with the decompression chamber 57. In a variant that is not shown, the decompression chamber is omitted.

The underwater vehicle 5 also comprises data cables 59; a
10 power cable 60, a supply tube 61 when necessary for supplying breathable air, a supply tube 62 when necessary for supplying pressurized oil and a supply tube 63 when necessary for supplying compressed air to the work devices 52 instead of to the battery 53 and the reserves 54, 55 and 56 of breathable
15 air, pressurized oil and compressed air.

The data cables 59 are connected to respective terminals 64, the power cable 60 is connected to a terminal 65, and the supply tubes 61, 62 and 63 are connected to respective
20 terminals 66, 67 and 68.

Terminals 64, 65, 66, 67 and 68 are mounted on connecting device 29 and are designed to engage with terminals 42, 43, 44, 45 and 46 and ensure a stable connection and the
25 continuity of the respective supplies. The connecting devices 29 and 32 are respectively designed so as to effect reciprocal centring with at least partial positive coupling by the shape of the parts, so as to ensure automatic engagement of terminals 42, 43, 44, 45 and 46 with the respective terminals
30 64, 65, 66, 67 and 68.

In use, the support vessel 6 is positioned over the submarine 2 in distress and launches into the body of water 4 the underwater vehicle 5 assigned to performing the rescue
35 operations for survivors on board the submarine 2 in distress. The underwater vehicle 5 makes a reconnaissance of the

submarine 2 in distress and, based on the reconnaissance, deploys a rescue operation strategy. The operation strategy may also require support from the auxiliary ROV 7. It is definitely a good rule that the auxiliary ROV 7 is in any case launched into the body of water 4, ready to perform support operations and/or connect itself to the underwater vehicle 5 in case of necessity. The coupling operations between the underwater vehicle 5 and the auxiliary ROV 7 take place in the body of water 4 and are carried out via the connecting devices 29 and 32.

The connection between the connecting devices 29 and 32 establishes the functional connection between the resident control device 47 of the underwater vehicle 5 and the remote control device 11. In this case, the control device 11 is defined as remote because it is located on the support vessel 6 in a remote position both with respect to the underwater vehicle 5 and with respect to the auxiliary ROV 7.

This connection between the remote control device 11 and the auxiliary control device 37 permits assigning the master or slave mode to the remote control device 11 and, in consequence, the slave or master mode to the resident control device 47. Selection of the preferred or necessary operating mode is made via the remote user interface 12 or the resident user interface 50.

The mechanical connection between the underwater vehicle 5 and the auxiliary ROV 7 also automatically provides the functional connection between remote supply unit 14 and, if necessary, the remote units 15, 16 and 17, as they are located on the support vessel 6, and the work devices 52 on board the underwater vehicle 5 so as to be able to compensate for possible failures of the battery 53 and of the reserves 54, 55 and 56.

From the operational viewpoint, the connection between the underwater vehicle 5 and the auxiliary ROV 7 enables simultaneously controlling the main propellers 26, any auxiliary propellers 27 of the underwater vehicle 5, and the
5 further propellers 31 of the auxiliary ROV 7 via the resident control device 47 or via the remote control device 11 so as to permit full manoeuvrability of the vehicle formed by the coupling of the underwater vehicle 5 and the auxiliary ROV 7.

10 Finally, with regard to the present invention, it is evident that variants can be made with respect to the embodiment described with reference to the accompanying drawings without however departing from the scope of the appended claims.

CLAIMS

1. An underwater vehicle for performing rescue operations in a body of water, the underwater vehicle (5) comprising: a submersible hull (25); a plurality of work devices (52); a resident control device (47) designed to permit fully independent operation of the underwater vehicle (5); at least one rescue apparatus (28) for performing rescue operations in the body of water (4); and at least a first connecting device (29) for mechanically and functionally connecting the underwater vehicle (5) to an auxiliary ROV (7) when necessary, and for connecting the plurality of work devices (52) and the rescue apparatus (28) to at least one remote supply unit (14, 15, 16, 17), and/or the resident control device (47) to a remote control device (11).

2. The underwater vehicle as claimed in Claim 1, wherein the first connecting device (29) comprises a plurality of first terminals (64, 65, 66, 67, 68) for making respective functional connections to the auxiliary ROV (7).

3. The underwater vehicle as claimed in Claim 1 or 2, wherein the rescue apparatus (28) comprises a selectively floodable chamber (58) for in-sea rescue.

4. The underwater vehicle as claimed in Claim 3, wherein the rescue apparatus (28) comprises a decompression chamber (57) communicating selectively with the floodable chamber (58).

5. The underwater vehicle as claimed in Claim 3 or 4, wherein the selectively floodable chamber (58) is selectively connectable to a submarine (2).

6. The underwater vehicle as claimed in any one of the foregoing Claims, wherein the resident control device (47) is

designed to operate in an independent operating mode and in a combined operating mode together with the remote control device (11), when the underwater vehicle (5) is connected to the auxiliary ROV (7).

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7. The underwater vehicle as claimed in Claim 6, wherein, in the combined operating mode, the resident control device (47) may be set selectively to master or slave mode.

10

8. The underwater vehicle as claimed in any one of the foregoing Claims, and comprising a resident user interface (50) for controlling the resident control device (47).

15

9. The underwater vehicle as claimed in any one of the foregoing Claims, and comprising at least one battery (53) and at least one breathable air reserve (54).

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10. The underwater vehicle as claimed in any one of the foregoing Claims, and comprising at least a main propeller (26) for fast movements; and preferably auxiliary propellers (27) for dynamic positioning.

25

11. A system for performing rescue operations in a body of water, and comprising: an underwater vehicle (5) as claimed in any one of the foregoing Claims; a support vessel (6) comprising a floating structure (10), at least one supply unit (14, 15, 16, 17) and a remote control device (11); and an auxiliary ROV (7) having a second connecting device (32) designed to mechanically and functionally connect to the first connecting device (29) of the underwater vehicle (5).

30

35

12. The system as claimed in Claim 11, wherein the first connecting device (29) comprises a plurality of first terminals (64, 65, 66, 67, 68), and the second connecting device (32) comprises a plurality of second terminals (42, 43, 44, 45, 46) for making functional connections to the first

terminals (64, 65, 66, 67, 68).

13. The system as claimed in Claim 11 or 12, and comprising an umbilical (19) designed to connect the support
5 vessel (6) to the auxiliary ROV (7), and which is functionally connected to the second connecting device (32)).

14. The system as claimed in any one of the foregoing Claims, wherein the remote control device (11) is housed on
10 the support vessel (6).

15. The system as claimed in any one of Claims 11 to 14, wherein the auxiliary ROV (7) comprises a further control device (37) controlled by the remote control device (11).

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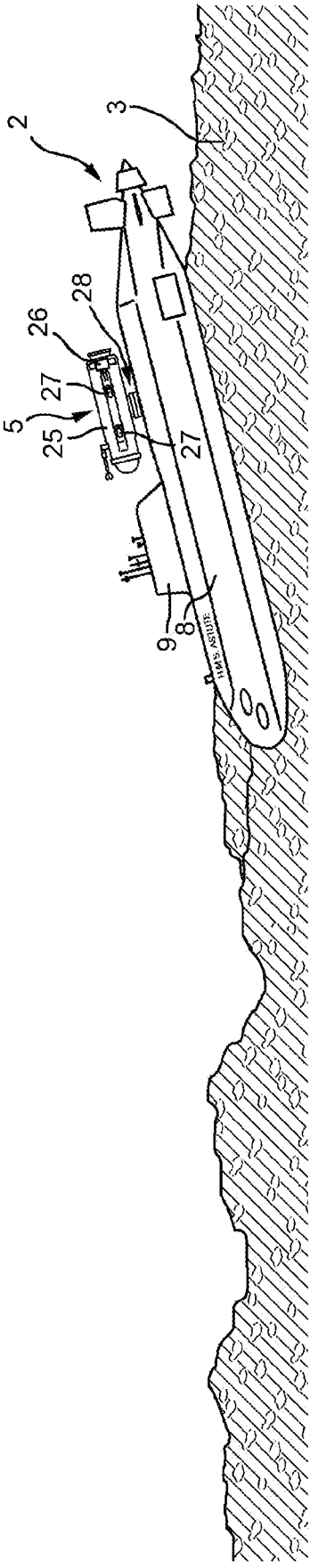
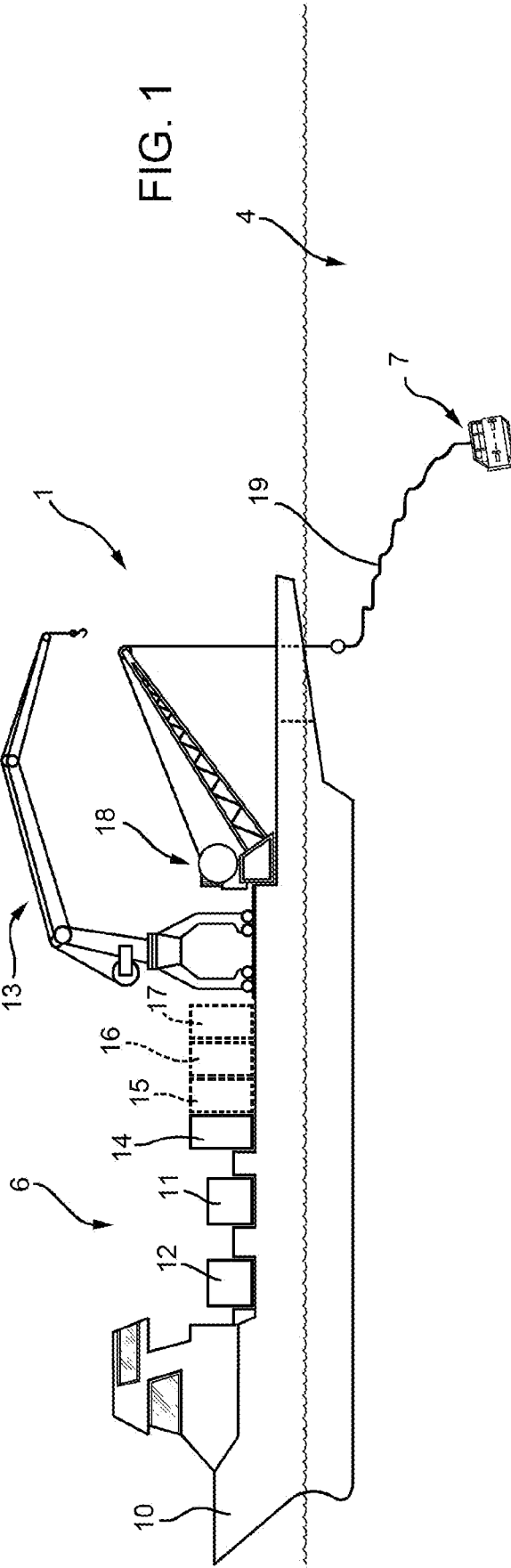
16. A method of performing rescue operations in a body of water, the method comprising the steps of: launching into the body of water (4) an underwater vehicle (5) designed to rescue persons from a submarine (2) in distress; launching an
20 auxiliary ROV (7) into the body of water (4); and mechanically and functionally connecting the underwater vehicle (5) to the auxiliary ROV (7), in the body of water (4), by means of a first and second connecting device (29, 32) mounted on the underwater vehicle (5) and the auxiliary ROV (7),
25 respectively.

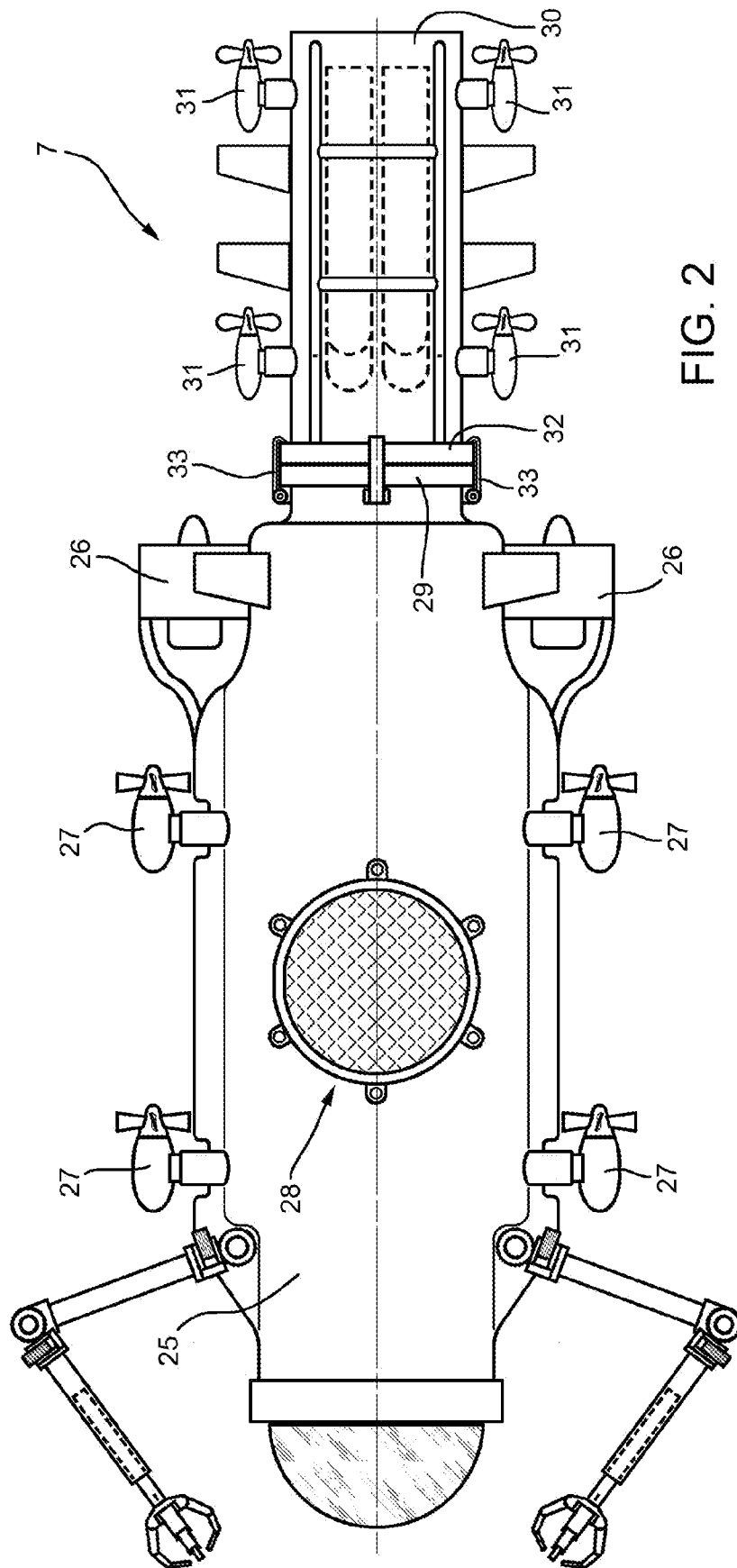
17. The method as claimed in Claim 16, and comprising the step of functionally connecting the resident control device (47) of the underwater vehicle (5) to a remote control device
30 (11) by means of the auxiliary ROV (7) and by means of the first and second connecting device (29, 32) and an umbilical (19).

18. The method as claimed in Claim 16 or 17, and comprising the step of functionally connecting at least one
35 remote supply unit (14, 15, 16, 17) to at least one work

device (52) on board the underwater vehicle (5) by means of the first and second connecting devices (29, 32) and the umbilical (19).

- 5 19. The method as claimed in any one of Claims 16 to 18, wherein the underwater vehicle (5) comprises at least a main propeller (26) and auxiliary propellers (27), and the auxiliary ROV (7) comprises further propellers (31), the method comprising the step of controlling the main propeller
10 (26), the auxiliary propellers (27), and the auxiliary ROV (7) by means of the resident control device (47) or the remote control device (11), when the underwater vehicle (5) and the auxiliary ROV (7) are connected to each other.





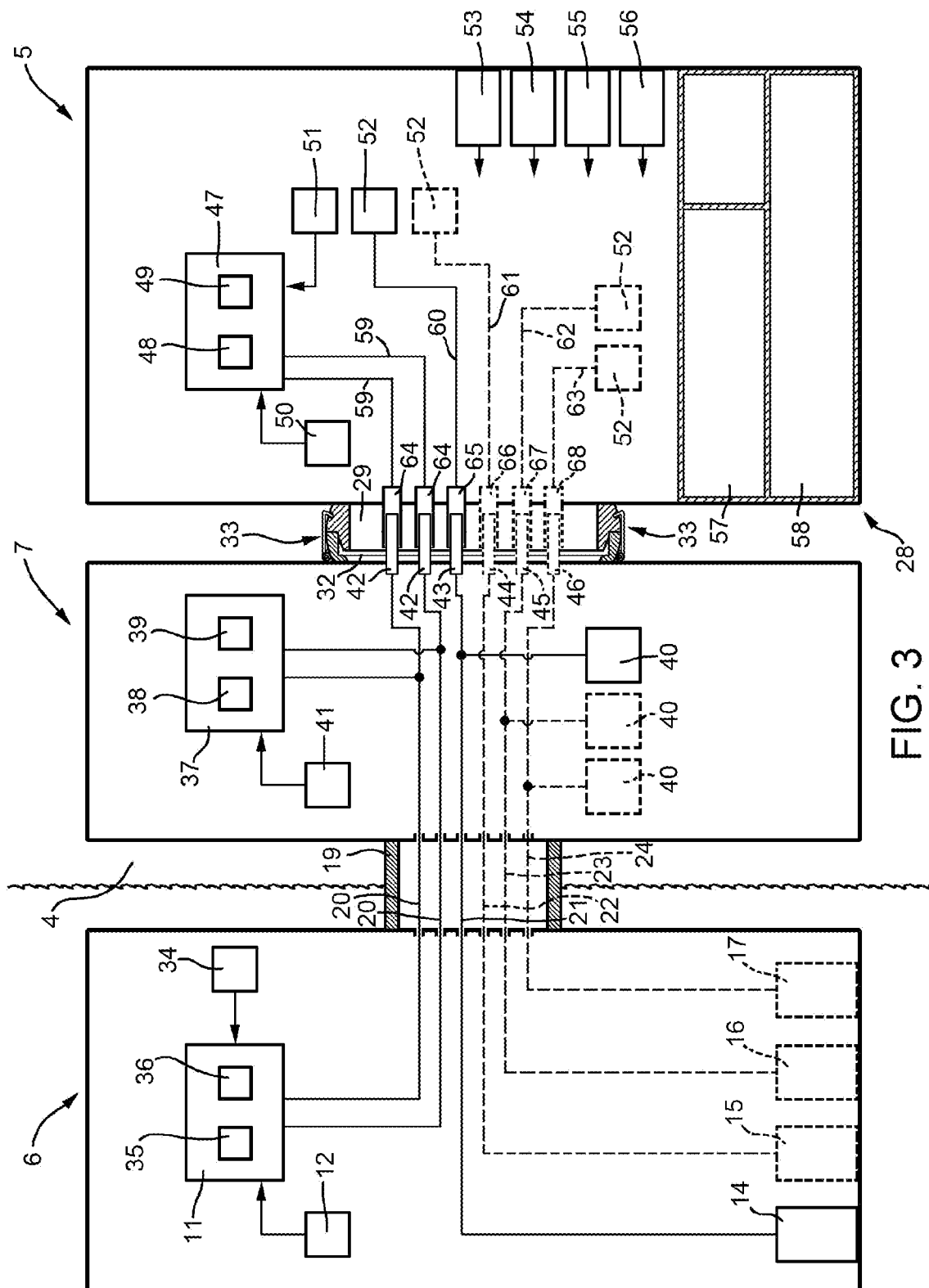


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/055236

A. CLASSIFICATION OF SUBJECT MATTER

INV. B63G8/00 B63G8/40 B63C7/16
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B63G B63C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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